Major Trauma in Geriatric Patients

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Abstract: Contemporary trauma to the elderly, its severity and associated mortality and morbidity in 111 United States and Canadian trauma centers are described. Three-thousand eight-hundred thirty-three (3,833) trauma patients age 65 years or older are compared to 42,944 injured patients under age 65. Although both groups had equivalent measures of injury severity, the older group had higher case fatality and complication rates and longer hospital stays. The results raise important questions regarding the triage, acute care, accurate prediction of outcome, and hospital reimbursement for the elderly injured patient, with implications for care evaluation, quality assurance, and the long-term viability of trauma centers and systems of care. (*Am J Public Heath* 1989; 79:1278–1282.)

Introduction

Today, 11 percent of the United States populace (28.5 million persons) are age 65 or older and by the year 2020 this age group is projected to nearly double, reaching about 51 million.[1] In 1984, unintentional injury accounted for almost 24,500 deaths of persons age 65 and older, a death rate of 86 per 100,000 population,[2] more than twice the accidental death rate of all ages (39.3) and for 25 to 44 year olds (35.5).

In 1986, 816,000 person age 65 years and older were discharged from short-stay hospitals with a diagnosis of injury or poisoning.[3] Their average hospital stay was 9.8 days, and the number of bed days exceeded 7.9 million, representing 38 percent of hospital bed days for all patients in which injury was the primary cause of admission.[3] At the 1986 average daily costs in hospital ($500) and in intensive care units (ICU) ($1250–$2000),[4,5] their hospital expenses exceeded $4.4 billion. Increased hospital costs due to longer lengths of stay in hospital and ICU, and more frequent complications,[6,7] are factors contributing to the elderly's disproportionate consumption of approximately one-third of the health care resources expended on trauma care.[8]

Although injury to the elderly consumes a significant proportion of trauma care resources, research has focused on the pediatric and young adult populations. Research has produced quantitative indices of injury severity such as the Trauma Score[9] and the Pediatric Trauma Score,[10] but no comparable scales have been developed specifically for the elderly. A comparative study, however, has shown that the injured elderly differ from their young counterparts in injury etiology, mortality, complications, and cost.[11] A comprehensive picture of injury to the elderly has not emerged and the implications for health care planning remain largely unknown, unquantified, or dimly perceived.

Since 1982, numerous North American hospitals have submitted data and information for seriously injured patients to the Major Trauma Outcome Study (MTOS),[12] sponsored by the American College of Surgeons Committee on Trauma. Data are analyzed periodically and confidential results are sent to participating institutions to support outcome evaluations and quality assurance activities.

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This paper compares data from the older (≥65 years) and younger (<65 years) MTOS patients to identify the differences between the two groups and the implications for injury prevention, triage, treatment, outcome evaluation, reimbursement, and additional research.

Methods

Data Base

The MTOS data base includes demographics, cause of injury, injury severity, complications, and outcome information for submitted patients. Detailed text injury descriptions obtained at discharge or death are provided based on surgical examination, x-ray, computerized tomography (CT) scan, and/or autopsy.

Data from 3,833 patients 65 years or older (the "older group") and 42,944 patients less than 65 years (the "younger group") were analyzed. Patient data were submitted from 1982 through 1986 by 111 US and Canadian hospitals participating in MTOS. Ninety-five participants (85.6 percent) reported being Level I or Level II trauma centers.

MTOS participants are required to identify a physician site director and nurse coordinator who are responsible for overseeing data collection, data quality and completeness, and data submission to the study analysis site. The MTOS packet describes the periodic reports prepared for participants, provides operational definitions for each data element, defines the specificity required of anatomic injury descriptions, and suggests sources for data abstraction, i.e., physician and/or operative notes and CT reports.

Collected data are forwarded to a study analysis center in Washington DC, where experienced coders check for data face validity, ensure essential data have been reported, and check the adequacy of submitted injury descriptions for coding. Anatomic injury descriptions are coded according to the International Classification of Disease taxonomy (ICD-9-CM)[13] and for severity using the 1985 version of the Abbreviated Injury Scale (AIS).[14] Data are keypunched, verified, and corrected for analysis. Extensive computer quality control checks are intended to minimize coding errors and to ensure the accuracy, completeness, and consistency of submitted data. When necessary, participants are asked to confirm, clarify, or supplement vague information or missing or unusual data.

Indices of Injury Severity

Patient physiologic status on emergency department arrival is characterized by the Revised Trauma Score (RTS),[15–17] a function of admission values of the Glasgow Coma Scale (GCS), systolic blood pressure (SBP), and respiratory rate (RR) (Appendix). The RTS takes values from 0 to 7.8408. Lower RTS values are associated with poorer prognoses.

The RTS replaced the Trauma Score (TS)[9] as the MTOS physiologic severity index. Development of the RTS was motivated by TS limitations; the TS underestimates severity for some head-injured patients and includes variables difficult to obtain in the field (capillary refill and respiratory expansion). The RTS has been shown to be a more reliable predictor of survival/death outcome than the TS.[15]

Anatomic injury severity is measured by the Injury Severity Score (ISS),[18] an index derived from the Abbreviated Injury Scale (AIS)[14] severity scores for individual injuries. The ISS takes values from 1 to 75. Higher scores generally indicate more severe injuries. Studies have shown that the ISS is correlated with mortality; lower correlations have been observed between ISS and length of hospital stay and disability.[18–20]

MTOS survival probability norms are based on the TRISS index.[16,21] TRISS is a severity index which includes the RTS, ISS, and patient age. The mathematical form of the norms is the logistic function $P_s = 1/(1 + e^{-b})$ in which P_s is patient survival probability, $b = b_0 + b_1(\text{RTS}) + b_2(\text{ISS}) + b_3(\text{AGE})$. Age is 0 for patients <55 years, and 1 for patients ≥55 years of age. The "b"s are regression weights.

TRISS norms are used in the PRE (preliminary outcome evaluation) methodology to support quality assurance activities. Patient ISS and RTS scores are plotted on a scatter diagram (Figure 1). Patients whose coordinates are on the diagonal line (determined by setting b = 0 in the norm equation) are estimated to have a 0.50 survival probability. Coordinates above (below) the line have estimated survival probabilities that are less than (exceed) 0.50. In Figure 1, survivors (L = living) above the line and non-survivors (D = dead) below it represent patients with unexpected outcomes, suggested by the American College of Surgeons to be worthy of peer review.[17]

Statistical Analysis

Statistical comparisons of attributes or outcomes of the older and younger patient samples use the chi-square test for frequencies and z-tests for comparisons of means.

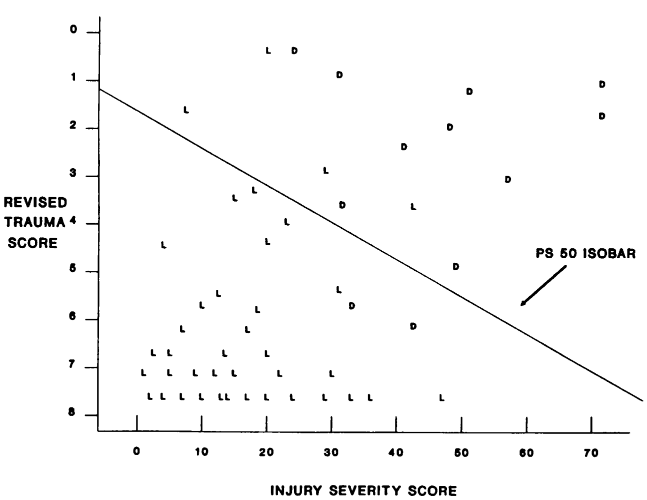

FIGURE 1—Example of a PRE (Preliminary Outcome Evaluation) chart
Key: L = Living
D = Dead

Results

Elderly study patients had a mean age of 76.3 years (sd = 7.8, range 65 to 104 years). Mean age for the younger group was 28.1 years (sd = 13.4, range 1 to 64 years). The male/female ratios for the older and younger groups were .93 and 3.3. The respective mortality rates were 19.0 percent (727/3,832) and 9.8% (4,180/42,860).

Distributions of cause of injury and their associated case fatality rates differed substantially (Table 1). Falls were the most frequent cause of injury to the elderly and had the lowest mortality rate. Motor vehicle accidents, the most prevalent cause of injury in the younger group, was the second most frequent cause of injury to the elderly. Gunshot wounds resulted in the highest case fatality rates in both groups. The elderly showed statistically higher case fatality rates in all etiological categories, except motorcycle injuries and "unknown," for which elderly samples were small.

The severity of anatomic injury and admission physiology as measured by average values of ISS and RTS were not statistically different for the two groups. Mean ISS values were nearly equal for the older and younger groups (13.3 and 13.4, respectively) and mean RTS values were equal (7.0). The difference between the mean ISS values for elderly and young non-survivors (24.1 and 30.2) is substantial, however (6.1, 95% confidence intervals 7.1, 5.1). Elderly non-survivors had a mean RTS at emergency department admission of 4.6, the younger non-survivors had a mean RTS of 2.8 (difference 1.8, 95% CI 2.0, 1.6).

Survival rates for injuries to specific body regions by maximum severity levels are given in Table 2. For example, of patients whose most severe injury was AIS 3 to the thorax, 83.8 percent of the elderly patients survived compared to 95.2 percent of the younger patients. (In Table 2, a patient's outcome is included in the results for each body region sustaining an injury of maximum severity. Thus, the cell entries in a row may not be independent.) The proportion of elderly who died was higher for every severity level/body region combination; differences were especially marked for abdominal injuries (11.5 percent fatality in the younger group and 29.5 percent in the older group). A high proportion of head injuries died in both groups.

Table 3 gives proportions of deaths and complication by ISS interval for the two groups. Mortality increased with higher ISS scores for both patient groups. For every interval, the percentage of deaths of the older group was higher than those of the younger group; the difference was generally greater for ISS values of 25 or more. For ISS values <25

TABLE 1—Mechanism of Injury, Relative Frequency, and Case Fatality Rate

	Ages ≥65		Ages <65	
Mechanism of Injury	% Relative Frequency (N: 3,833)	% Case Fatality Rate	% Relative Frequency (N: 42,944)	% Case Fatality Rate
Fall	40.6	11.7	11.0	6.0
Motor vehicle accident	28.2	20.7	33.5	9.6
Pedestrian hit	10.0	32.6	7.9	13.5
Stab wound	2.6	17.3	11.9	4.7
Gunshot wound	5.5	52.1	13.0	19.5
Motorcycle	0.4	11.8	7.7	11.9
Other	7.0	13.8	14.9	5.4
Unknown	0.3	19.0	0.1	9.8
Total	100	—	100	—

TABLE 2—Percent Survival for Elderly/Younger Patients by AIS Severity and Location of Most Severe Injury

Maximum AIS Severity	Location of Most Severe Body Injury: Head and Neck	Face	Thorax	Abdomen, Pelvis	Extremities	External
1	100 /100	94.7/99.7	95.7 /100	100 /100	100 /100	99.7 /100
2	92.6/99.3	95.8/99.6	95.9/99.3	93.3/99.4	94.9/99.5	95.6/99.7
3	66.4/88.1	84.2/98.1	83.8/95.2	77.4/94.7	92.4/96.7	—/98.2
4	54.9/73.2	69.2/76.3	65.6/78.3	65.4/86.7	37.5/88.0	—/77.8
5	26.1/48.0	—/—	23.5/53.8	21.7/66.8	—/69.2	—/37.5

TABLE 3—Percentage of Deaths/Complications According to Injury Severity Score (1985)

ISS Range	Age ≥65	Age <65
0–8	2.9/16.2	0.3/05.8
9–15	6.9/31.1	2.7/17.1
16–24	28.9/48.3	10.5/30.1
25–40	51.4/56.7	29.3/42.9
41–49	73.7/55.3	50.0/53.6
50–74	90.5/61.9	65.2/42.6
75	94.4/38.9	89.9/25.3

(relatively minor or single system injuries), proportions were 9.9 percent and 3.3 percent for older and younger patients, respectively. For patients with an ISS >50 (severe multisystem injuries), most cases in both groups died (92 percent older versus 78 percent younger).

Complications for older (33.4 percent) and for younger patients (19.4 percent) are also very different. Pulmonary complications were most frequent in both groups. Cardiovascular complications were much more common in older patients (9.8 percent) than younger patients (2.1 percent). Complications were substantially more frequent at the less severe ISS intervals for elderly patients than for younger patients.

There were 5.5 percent of blunt-injured MTOS patients and 3.8 percent of patients with penetrating injuries who had "unexpected" outcomes according to TRISS projections (Figure 1). Most striking are those at the extremes of the survival probability scale: 465 unexpected MTOS deaths had estimated survival probabilities exceeding .90. Approximately 30 percent of those patients were ≥65 although the elderly represent only 8.2 percent of all MTOS patients. Most of those patients had no major injury (AIS >3) and had excellent physiology when admitted to the emergency department.

Survivors and non-survivors in the older group had substantially longer average lengths of stay in the hospital and in the ICU than the younger group (Table 4).

Discussion

MTOS findings confirm those of other studies which have shown that the elderly are more vulnerable to injury than their younger counterparts, die more frequently, and have longer hospital stays for injuries of comparable severity.[22,23] This increased vulnerability has in part altered the perception that injury is a disease of the young who, because of the focus on years of productive life lost, have been the beneficiaries of research efforts and health policy thrusts. The magnitude of the problem of injury to the elderly is now being more fully recognized. By 1995, 35 million US citizens will be more than 65 years old. At the current elderly injury mortality rate (86 per 100,000) 30,100 elderly people will die from injuries in 1995. Further, recent studies suggest that trauma is underreported and represents a more prevalent cause of death in the elderly than is officially recognized.[24] The high costs of hospitalizing and treating the elderly are motivating health care providers to examine the efficacy of injury prevention programs and trauma care.

TABLE 4—Mean Length of Hospital and ICU Stay (Days)

Age (years)	Survivors: Hospital	Survivors: ICU	Non-Survivors: Hospital	Non-Survivors: ICU
≥65	15.7	3.1	9.9	6.0
<65	12.2	2.6	4.2	3.1

There are, however, few reported studies of injury to the elderly and most of those have limited sample sizes. The MTOS thus provides a unique opportunity to study a large number of contemporary, elderly injured. The entire MTOS patient sample represents approximately 0.4 percent of all injured patients hospitalized in the United States, approximately 1.0 percent of all trauma deaths, and 2.0 percent of all in-hospital trauma deaths during the four-year study period. Although the MTOS patient sample is not population based and biased toward the more severely injured patients (more than 85 percent of participating institutions are Level I or Level II trauma centers), the data base focuses on those injuries that are most costly, require a large consumption of health care resources, and perhaps have the greatest impact on the utilization and delivery of trauma care and the formulation of prevention programs.

For example, although falls are the most frequent cause of injury in the elderly, automobile injuries (motor vehicle and pedestrian) result in the most deaths in this age group. The 20.7 percent mortality rate in MTOS for elderly victims of motor vehicle trauma (versus 9.6 percent in the younger group) substantiates the toll of this category of injury. Strategies such as driver improvement programs have been designed to reduce the incidence of motor vehicle deaths in older people, and some state motor vehicle departments and insurance companies have reported a lower incidence of fatalities and collisions from these programs.[25,26] Gunshot wounds, however, are only dimly perceived as a problem in this population. Although the incidence (5.5 percent) is much lower than other injuries, more than half the MTOS gunshot victims age 65 and older died. The rising homicide rate in many cities and higher risk of elderly suicide portend a problem of possibly greater proportions that could require a more focused prevention/treatment strategy.

At the other end of the spectrum are injuries of lesser severity such as hip fractures, which are often the result (or the cause) of falls in the elderly. The MTOS data base showed an increasing mortality with age in patients whose only injury was a hip fracture. An injury that is easily survivable in the younger population can result in life-threatening consequences for the older group. Identifying such specific causes of vulnerability in the elderly group can target areas for treatment and prevention programs.

A precise characterization of the injury severity of the elderly is as yet unavailable. MTOS outcome prediction results are subject to limitations of the ISS, which have been described,[27] and of the AIS, which assigns severity scores to individual injuries, independent of patient age. Also, investigations of the relation between physiologic scores, such as the RTS, and survival rate among elderly patients have not been reported. Although current injury characterizations include the effect of patient age in a coarse way, factors such as pre-injury illness, disease, or functional level are not considered. These are particularly germane to the elderly group whose susceptibility to complications are well known and who can be at greater risk of dying even when physiology appears normal. The importance of these factors in the characterization of injury to the elderly suggests that more accurate predictions of outcome are possible and necessary. This has been recognized in the pediatric population, for whom a review and reassessment of their AIS scores have already been accomplished.*

MTOS data currently include patient outcomes for survival/death and length of stay in hospital and in ICU. Because of cost and limited resources, most participants cannot perform post-discharge functional assessments, although selected elements of the Functional Independence Measure (FIM)[28] are now being collected. With the limited outcome data, an assessment of the efficacy of trauma center care for the elderly is difficult; refinements are not possible, e.g., determining whether the center benefits elderly injured patients in general or only certain subsets. Such findings could have important system applications such as formulating guidelines for triage. The substantial number of blunt-injured, elderly, "unexpected deaths" identified in MTOS suggests the need to review existing triage criteria endorsed by the American College of Surgeons Committee on Trauma (ACSCOT).[29] Those criteria are based on values of RTS variables and mechanism of injury information. Patient age is mentioned, but unemphatically.

The need for a better understanding of whether the elderly benefit from trauma center care is fueled by the growing emphasis on health care cost containment. Under the prospective payment system, hospital reimbursement is based on DRGs, sets of medically similar diagnoses with approximately equal lengths of stay. Because of the heterogeneity of trauma patients, their hospital stays are bimodal and not well represented by the DRG average. A study of hospital lengths of stay for Maryland patients of all ages with trauma-related DRGs found substantially more variation than for non-injury DRGs considered by many to be the most variable under the system.** Researchers have also noted that among the 469 DRGs, only 96 are adjusted for the elderly. MTOS data suggest the effect of age for all levels of injury severity, and therefore across many diagnoses. Several other analyses suggest that the current system could undermine the financial viability of trauma care systems.[30–32]

MTOS findings indicate that the effect of trauma to the elderly is more serious than to the younger population. The perception of injury as a disease of the young and the use of inadequate physiologic and anatomic indices for this population fail to recognize how trauma affects the elderly and how trauma centers and systems can most effectively be utilized in their care. The elderly, because of their growing numbers, vulnerability to injury, and the significant cost of their trauma care, should be a new focus for trauma research and health policy examinations.

*Susan Baker, PhD, Johns Hopkins University, personal telephone communication.

**Johns Hopkins University proposal to National Center for Health Services Research. Study of Trauma-Related DRGs, 1986. Baltimore, MD: JHU, 1986.

APPENDIX

Revised Trauma Score

Motivated by insights from audits of patients with "unexpected outcomes" identified in the September 1985 MTOS analysis, the Trauma Score (TS) was modified. The Revised Trauma Score (RTS) includes the Glasgow Coma Score (GCS), Systolic Blood Pressure (SBP) and Respiratory Rate (RR).

RTS VARIABLE BREAK POINTS
CODED VALUES

GCS	SPB	RR	Coded Values
13–15	>89	10–29	4
9–12	76–89	>29	3
6–8	50–75	6–9	2
4–5	1–49	1–5	1
3	0	0	0

Each variable takes on coded values from 0 to 4 based upon its raw value. The break-points defining coded values are given below.

Empirically derived weights were obtained for each coded variable from a regression analysis of data from 26,011 consecutive patients from 51 MTOS "norm" institutions. The RTS is defined as

$$RTS = .9368\ (GCS_c) + .7326\ (SBP_c) + .2908\ (RR_c)$$

where the subscript c indicates coded value.

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HRSA Provides Financial Aid to Disadvantaged Students in the Health Professions

More than $5.3 million in grants were awarded recently by the Health Resources and Services Administration (HRSA) to 193 schools in 45 states, the District of Columbia, and Puerto Rico to provide financial assistance to disadvantaged students of medicine, dentistry, or osteopathy. The schools are responsible for selecting students to be assisted. Students from disadvantaged backgrounds who meet exceptional financial need criteria are eligible for support. The aid grants carry no service or financial obligations and may be used for tuition and other reasonable educational expenses. Institutions receiving grants are located in all states except Alaska, Delaware, Idaho, Montana, and Wyoming.

Additionally, grants totaling more than $6.5 million were awarded by HRSA to 298 health professions schools in 46 states, DC, and Puerto Rico to provide scholarships for students in exceptional financial need. Participating schools will award the scholarships to support students of medicine, osteopathy, dentistry, optometry, pharmacy, podiatric medicine, and veterinary medicine during the 1989–90 school year. Those individuals eligible for these scholarships are students in any class year whose resources do not exceed the lesser of $5,000 or one-half the cost of school attendance. The scholarships carry no service or financial obligations. Institutions receiving scholarship funds are located in all states except Alaska, Delaware, Montana, and Wyoming.

For further information about either of these student aid programs, contact Blake Crawford, Health Resources and Services Administration, USPHS, DHHS, 5600 Fishers Lane, Room 14–43, Rockville, MD 20857. Tel: 301/443-3376.